maintained that both were artifacts of the staining techniques used to see them. Even those who accepted the reality of the organelles disputed what function they played. A major reason both for the claims of artifact and for the disputes about function was that cytologists had limited resources to determine the function of organelles. The major strategy was to correlate frequency of the organelles' occurrence with activities the cell was performing. Many cytologists saw that the best prospect for moving beyond this state involved linkages with biochemistry. During the first half of the twentieth century, while cytologists were struggling, biochemists were making rapid advances.

2. BIOCHEMICAL CONTRIBUTIONS TO DISCOVERING CELL MECHANISMS UP TO 1940

Biochemistry established itself in the early decades of the twentieth century in what was then underdeveloped territory between physiology and chemistry (Kohler, 1973; Kohler, 1982). It drew upon considerable research on chemical processes in living organisms in the nineteenth century, but did not develop its own methods and conceptual framework until the beginning of the new century. I will begin by briefly reviewing some of the foundations that were laid in the nineteenth century, discuss what distinguished biochemistry as it emerged in the twentieth century, and then describe in greater detail research on glycolysis (fermentation) and aerobic respiration in the period 1900 to 1940.

Foundations for Biochemistry in the Nineteenth Century

The first attempts to build bridges between chemistry and activities of living organism preceded the chemical revolution at the end of the eighteenth century, but with the emergence of a new chemistry outlined by Antoine Lavoisier these efforts acquired a new foundation.[23] Lavoisier himself contributed significantly to charting the path that subsequent investigators would follow. The new systemization of the basic elements led to analyzing organic substances in terms of these elements. Lavoisier (1781) determined that carbon, hydrogen, and oxygen are constituents of all living organic substances. Claude Louis Berthollet (1780) identified nitrogen as another frequently occurring component. With these foundations, investigators began trying to characterize physiological processes in terms of changes in elemental composition.[24] For

[23] For more detailed analysis, see Holmes (1963).

[24] Since different organic substances were composed from the same elements, many chemists concluded that they differed from one another only in terms of their relative proportions. Thus,